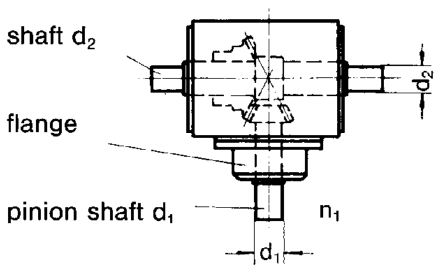
Determination of Application Data

Power	P	Kilowatt	kW	1 kW = 1,36 hp	Output torque $= T_{out}$
Torque	T	Newton-Metre	Nm	1 Nm = 0,102 kpm	Input torque $= T_{in}$
Speed	n	Revs.per minute	r/min	1 r/min = 0,1047 rad/s	Total ratio $= \boxed{i_{tot}}$
$T = \frac{30\,000}{\pi} \cdot \frac{P}{n} \approx 9550 \cdot \frac{P}{n}$					$T_{out} = T_{in} \cdot \boxed{i_{tot}}$

Determining the ratio and direction of rotation



Generally applicable: $i = \frac{n_1}{n_2} = \frac{\text{speed } n_1 \text{ of pinion } d_1}{\text{speed } n_2 \text{ of shaft } d_2}$

Note: The term ratio always applies regardless whether speed is increased or reduced.

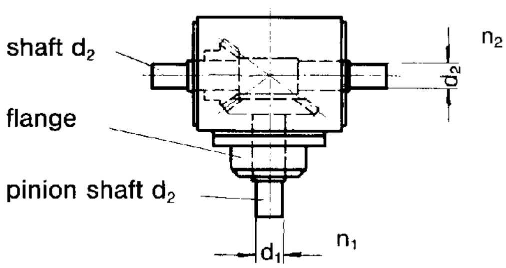
Example 1: Speed n_1 of pinion d_1 = 1500 r/min
Speed n_2 of driven shaft d_2 = 750 r/min

$$i = \frac{n_1}{n_2} = \frac{1500}{750} = \frac{2}{1} = 2:1$$

i.e. relative to n_1, speed reduction

When placing an order, the ratio specified by the Tandler must be observed. In order to avoid errors Tandler will assume that n_1 applies to pinion shaft d_1 (flange side) and n_2 applies to shaft d_2.

If d_2 is the driving shaft, a ratio of up to i = 3 is permissible, provided that the speed n_1 stated in this brochure is not significantly exceeded.



For speed increasing ratios from d_1 several options are available: 1:1,25, 1:1,5, 1:1,75, 1:2.

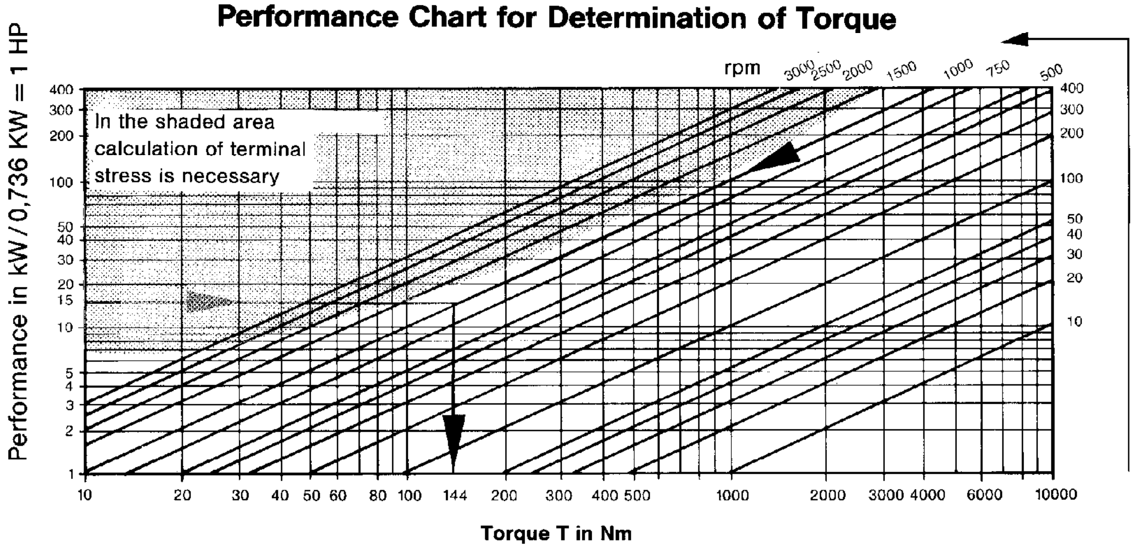
Example 2:

$$i = \frac{n_1}{n_2} = \frac{\text{speed } n_1 \text{ of pinion } d_1}{\text{speed } n_2 \text{ of shaft } d_2} = \frac{1000}{2000} = 1:2$$

i.e. relative to n_1 speed increase

Direction of rotation:
The directions of rotation indicated on gear arrangements are assumed. Opposite directions of rotation can also be selected.

Performance Chart for Determination of Torque



Example: given that N = 15 kW with n = 1.000 rpm, the resultant torque T = 144 Nm

Service Factors for the Selection of Gearboxes

The power characteristics of sizes/types 00-F1 represent the max. performance limits of the gearboxes. These ratings have been confirmed not only by calculation but also by extensive running on the test bench. Temperatures of 80^0 - 100^0 C were considered acceptable with oils having a viscosity of 46 C St at 40^0 C, or alternatively synthetic lubricating oils may be used. If, however, design data indicate that maximum ratings may be reached (e.g. the type of load applied), the 'c' factors (derived from Prof. Niemann) must be included in the calculation.

Degree of shock of driven machine	Prime Mover											
	Electric motor Running time in h per day				Piston motor, hydraulic motor Running time in h per day				Single-cylinder piston motor Running time in h per day			
	0,5	3	8	24	0,5	3	8	24	0,5	3	8	24
I	0,5	0,8	1,0	1,25	0,8	1,0	1,25	1,5	1,0	1,25	1,5	1,75
II	0,8	1,0	1,25	1,5	1,0	1,25	1,5	1,75	1,25	1,5	1,75	2,0
III	1,25	1,5	1,75	2,0	1,5	1,75	2,0	2,25	1,75	2,0	2,25	2,5

I almost shock-free, e.g. electric generators, screw conveyors, lightweight elevators, electric hoists, ventilators, agitators.
II moderate shock, e.g. heavy elevators, crane slewing gear, reciprocating pumps, shaft ventilators, cable hoists.
III heavy shock, e.g. punching and cutting machines, machinery used in rolling mills and the steel and iron industry, pug mills, weaving looms.

P_1 is the standard power in kW produced by the drive motor. T_2 is the standard torque in Nm delivered to the driven machine and c is derived from the table above as follows:

$$P_K = P_{1kW} \times c \qquad T_K = T_2 \times c$$

P_K = power as shown
T_K = torque as shown
} to characteristic lines of diagram

With high speeds and power rates **maximum thermal stress values** are also to be taken into account when selecting gearbox size, - see page 26.

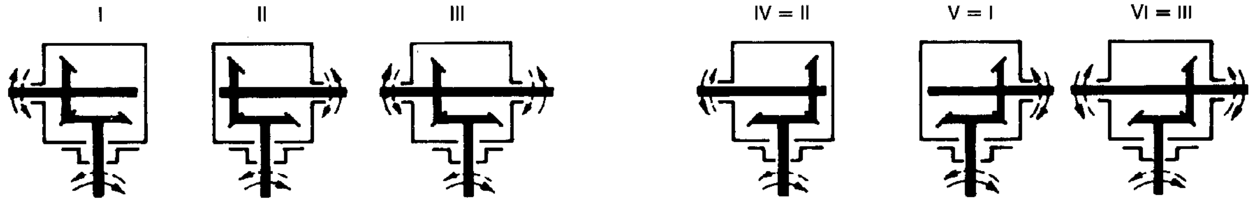
Examples of Gearbox Selection

n_1 = 1800 r/min; drive provided by an 8.8 kW piston engine with coninuous operation 22 h per day driving a reciprocating pump.
From the table above: degree of shock = II; 'c' factor = 1.75; therefore a load of up to 15.4 kW.
Size of gear required: A1 (see diagram of power characteristics).

n_1 = 1500 r/min; drive provided by an 8 kW electric motor with 9 h operation per day driving a reciprocating pump.
From the table above: degree of shock II: 'c' factor = 1.25; therefore a load of up to 10 kW.
Size of gear required: 01.

Internal Gear Arrangement

I II III IV = II V = I VI = III



Example of ordering:

HW - A1 - 2:1 - III

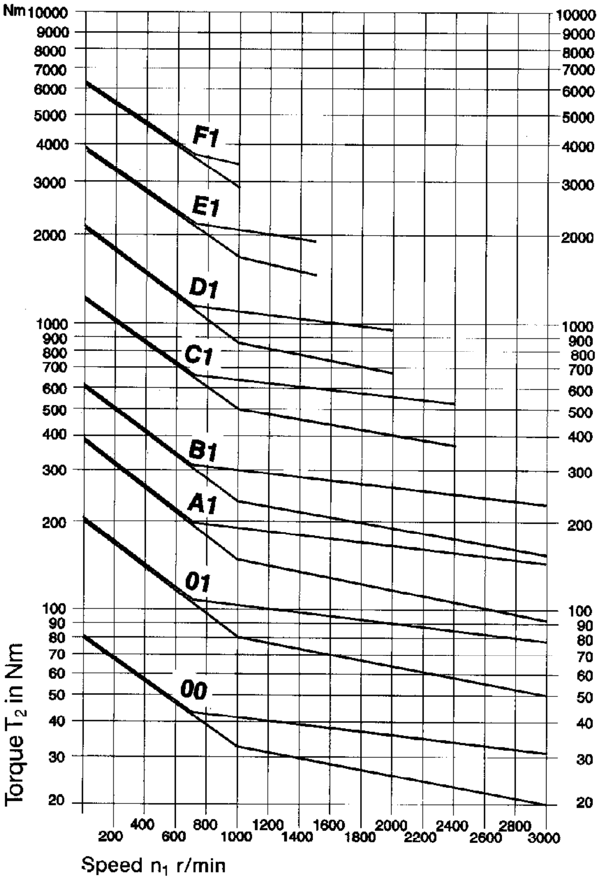
- Type/Series — HW
- size of gearboxes — A1
- Total ratio $i_{tot} = n_1 : n_2$ — 2:1
- Gear arrangement — III

Further important data required for the preparation of quotations:

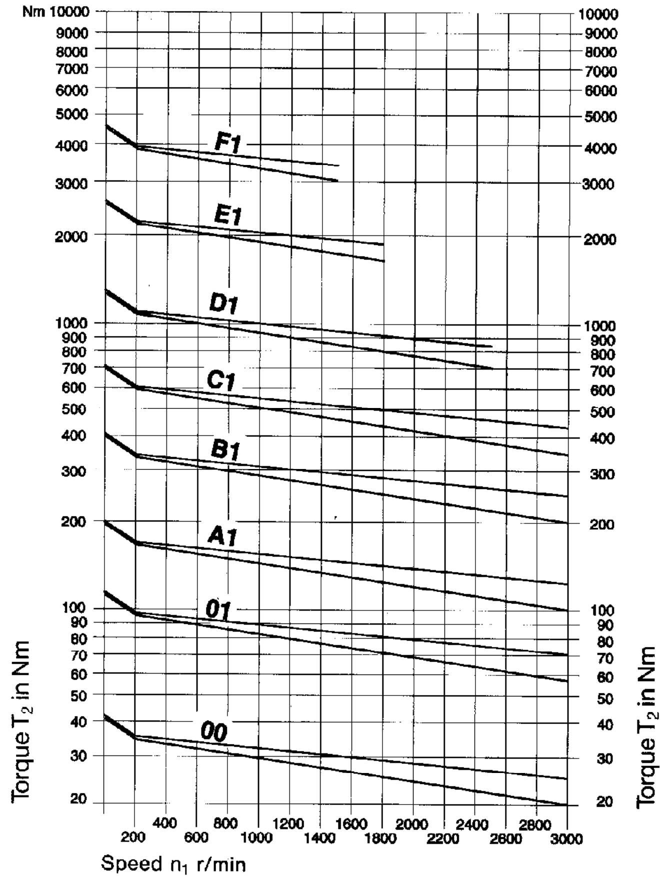
- Position of gears (shafts horizontal or vertical)
- Additional loads at shaft ends (e.g. belt drive)
- Gearbox environment (temperature, humidity, etc.)

Permissible Torque

i = 1:1



i = 1,25:1 u. 1,5:1



Standard box: ————————
Power box: ————————

Performance Data

Max. input power P_1 in kW and output torque T_2 in Nm

speed		ratios											
		i = 1		i = 2		i = 3		i = 4		i = 5		i = 6	
	n_1 r/min	P_1 kW	T_2 Nm	P_1 kW	T_2 Nm	P_1 kW	T_2 Nm	P_1 kW	T_2 Nm	P_1 kW	T_2 Nm	P_1 kW	T_2 Nm
00	1000	4,4	42	1,6	31	1,0	30	0,68	26	–	–	–	–
	1500	6,1	39	2,3	29	1,4	27	0,94	24	–	–	–	–
	3000	9,7	31	4,1	26	2,5	24	1,4	18	–	–	–	–
01	1000	11,5	110	4,5	85	2,9	82	1,8	67	1,4	65	0,91	52
	1500	15,0	97	6,3	80	4,0	77	2,5	64	1,9	62	1,3	48
	3000	25,0	78	11,0	68	6,8	65	4,5	57	3,4	54	1,9	36
A1	1000	20,0	190	8,9	170	5,8	165	3,6	137	2,8	134	1,8	105
	1500	28,0	180	13,0	160	8,1	155	5,1	130	4,0	127	2,4	92
	3000	47,0	150	21,0	135	14,0	130	8,6	110	6,6	105	3,7	70
B1	1000	31,4	300	17,0	320	11,0	315	6,5	248	5,0	240	3,3	190
	1500	44,0	280	24,0	300	15,0	290	9,2	235	7,2	228	4,5	170
	3000	72,0	230	41,0	260	26,0	245	16,0	205	12,0	195	6,8	130
C1	500	41,0	780	15,0	590	10,0	580	6,2	470	4,8	460	3,4	390
	1000	67,0	640	30,0	570	19,0	540	12,0	440	9,0	430	6,1	350
	1500	94,0	600	41,0	520	27,0	510	17,0	430	13,0	420	8,1	310
D1	500	78,0	1500	29,0	1100	19,0	1080	11,0	830	8,5	810	6,1	700
	1000	120,0	1150	52,0	1000	35,0	995	21,0	800	16,0	780	11,0	640
	1500	160,0	1050	74,0	940	49,0	935	30,0	760	23,0	740	16,0	600
E1	500	140,0	2750	58,0	2200	38,0	2200	29,0	2180	23,0	2150	11,0	1300
	1000	225,0	2150	110,0	2100	73,0	2100	55,0	2100	42,0	2000	21,0	1200
	1500	310,0	1950	150,0	1900	97,0	1850	73,0	1850	53,0	1700	29,0	1100
F1	500	230,0	4400	99,0	3800	65,0	3700	48,0	3680	38,0	3650	–	–
	1000	355,0	3400	190,0	3600	120,0	3500	92,0	3500	72,0	3450	–	–

subject to modification

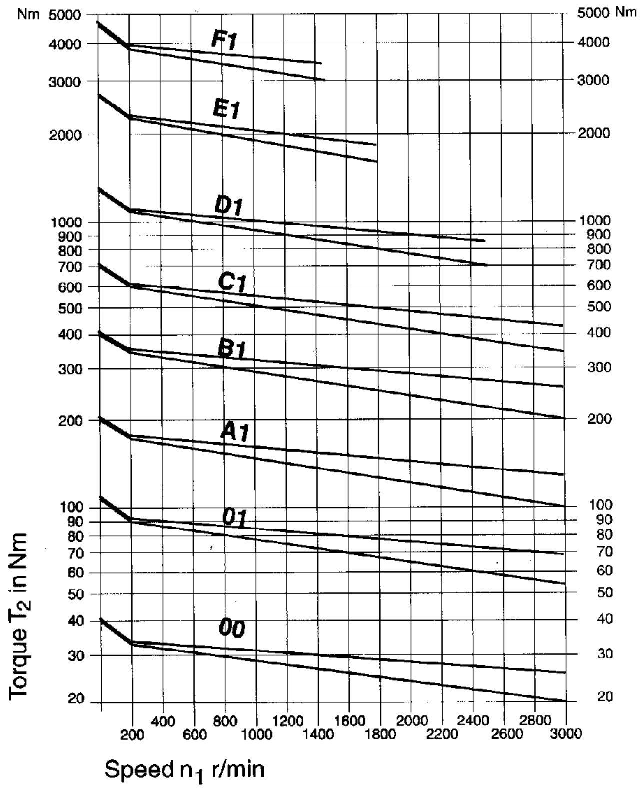
Permissible radial load in N for shafts d_1/d_2

Permissible load F_r in N[1)] for shaft jornal d_1 d_2		Permissible load F_r in N[1)] for shaft jornal d_1 d_2	
at ratio n i = 1 up to 3		at ratio n i = 4 up to 6	
d_1	d_2	d_1	d_2
300	300	–	–
1100	1100	1000	1100
1500	2700	1300	2700
2000	3700	1700	3700
3250	5000	2200	5000
3800	7500	2500	7500
4500	9200	3000	9200
7000	12000	3700	12000

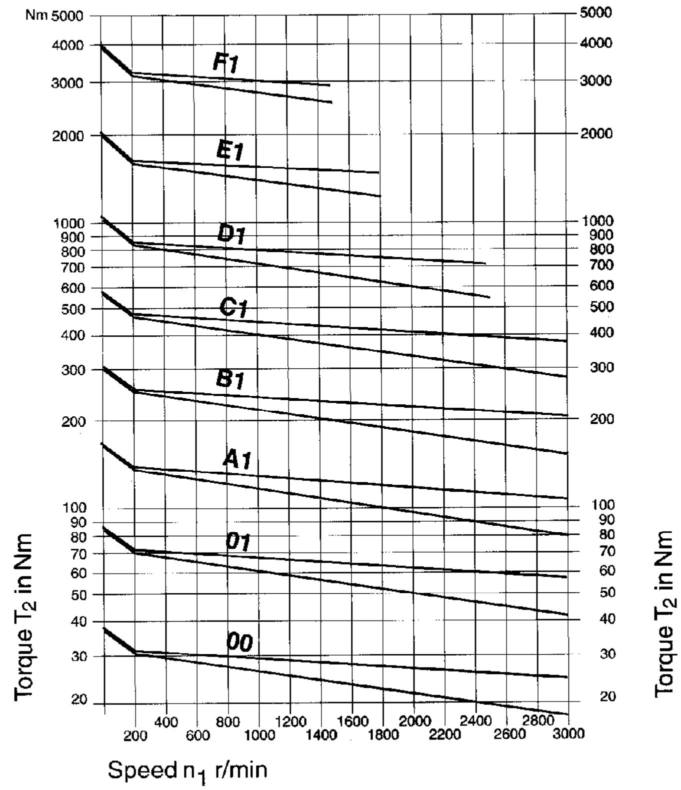
[1)] permissible load values represent standard values

Permissible Torque

i = 2:1 i = 3:1

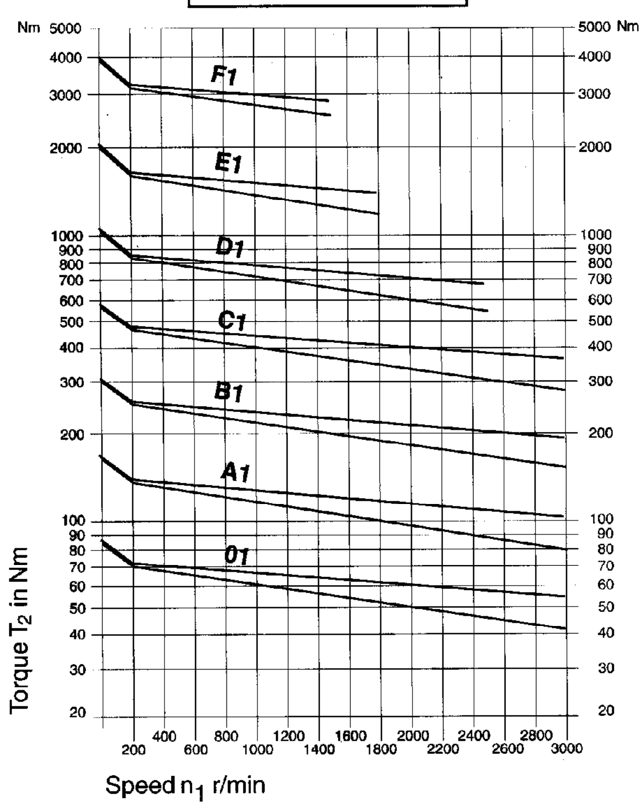


i = 4:1

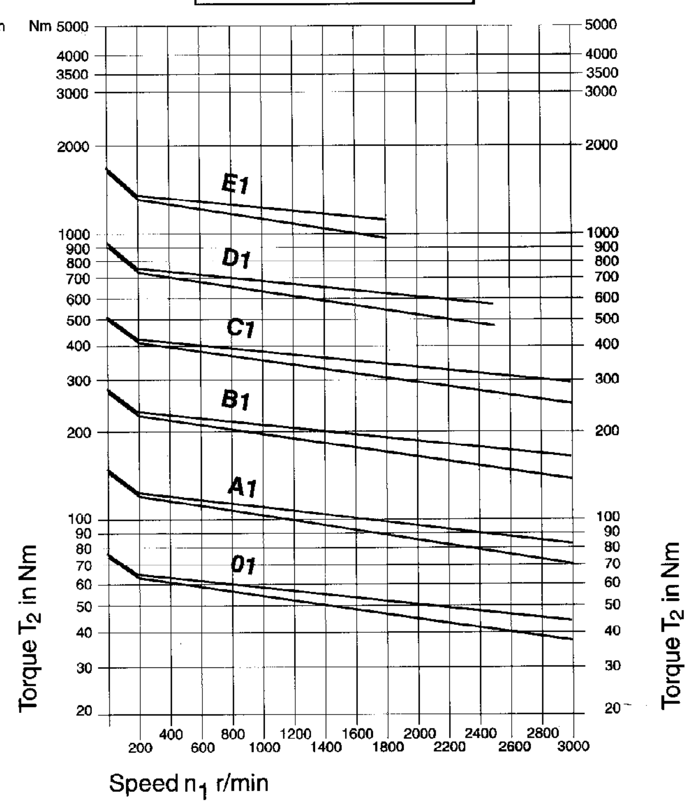


Standard box:
Powerbox:

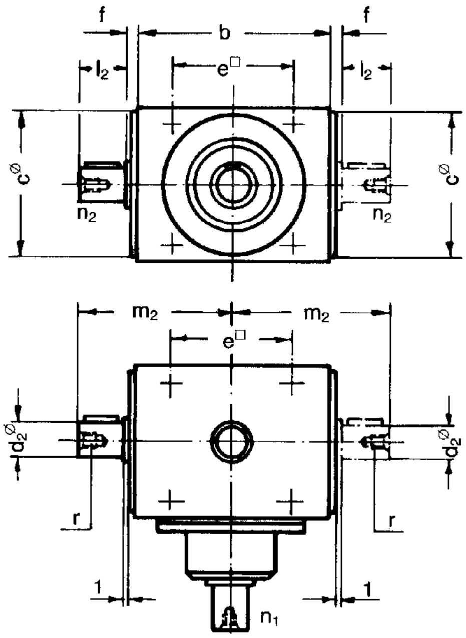
i = 5:1

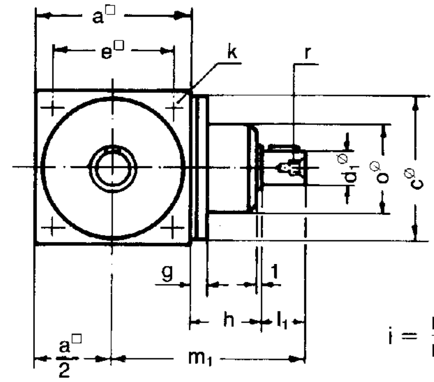


i = 6:1



Standard Version





$$i = \frac{n_1}{n_2}$$

Standard Version
Ratios from 1 to 6 for speed reduction
8 gearbox sizes max. torque up to 6200 Nm
palloid spiral bevel gears

Dimensions

Gearbox-size	General									d_2	
	a□	b	$c^{⌀}_{j7}$	$d^{⌀}_{2j6}$	e□	m_2	f	h	k[1])	r DIN 332	Key DIN 6885
00*	80	110	74	14	60	88,5	3,5	40	M 6	M 6	5x 5
01*	110	145	102	22	82	111	3,5	45	M 8	M 8	6x 6
A1*	140	175	130	32	105	137	4,5	50	M10	M10	10x 8
B1*	170	215	160	42	130	172	4,5	65	M12	M12	12x 8
C1*	210	260	195	55	160	220	5,0	85	M16	M16	16x10
D1	260	330	245	65	200	270	5,0	110	M16	M16	18x11
E1	330	430	310	75	260	340	5,0	150	M20	M20	20x12
F1	400	530	380	90	320	420	5,0	200	M24	M24	25x14

Ratios i=1:1; 1,25:1; 1,5:1; 1,75:1; 2:1; 2,5:1

Gearbox-size	i=1:1 bis 2,5:1						d_1	
	l_2	g	$d^{⌀}_{1j6}$	l_1	m_1	o⌀	r DIN 332	Key DIN 6885
00*	30	13	14	30	110	52	M 6	5x 5
01*	35	14	22	35	135	70	M 8	6x 6
A1*	45	14	32	45	165	90	M10	10x 8
B1*	60	18	42	60	210	110	M12	12x 8
C1*	85	18	55	85	275	135	M16	16x10
D1	100	23	65	100	340	150	M16	18x11
E1	120	29	75	120	435	230	M20	20x12
F1	150	40	90	150	550	270	M24	25x14

Ratios i=3:1

Gearbox-size	i=3:1						d_1	
	l_2	g	$d^{⌀}_{1j6}$	l_1	m_1	o⌀	r DIN 332	Key DIN 6885
00*	30	13	12	25	105	52	M 5	4x 4
01*	35	14	22	35	135	70	M 8	6x 6
A1*	45	14	32	45	165	90	M10	1x 8
B1*	68	18	36	55	205	100	M12	10x 8
C1*	85	18	38	65	255	135	M12	10x 8
D1	95	23	55	85	325	135	M16	16x10
E1	120	29	55	85	400	190	M16	16x10
F1	150	40	75	120	520	270	M20	20x12

Ratios i=3,5:1

Gearbox-size	i=3,5:1						d_1	
	l_2	g	$d^{⌀}_{1j6}$	l_1	m_1	o⌀	r DIN 332	Key DIN 6885
00*	30	13	12	25	105	52	M 5	4x 4
01*	35	14	16	30	130	70	M 6	5x 5
A1*	45	14	20	32	152	80	M 8	6x 6
B1*	68	23	26	45	200	80	M 8	8x 7
C1*	85	18	32	45	235	105	M10	10x 8
D1	95	28	42	70	310	110	M12	12x 8
E1	120	29	50	75	390	190	M16	14x 9
F1	150	40	60	95	495	200	M16	18x11

Ratios i=4:1

Gearbox-size	i=4:1						d_1	
	l_2	g	$d^{⌀}_{1j6}$	l_1	m_1	o⌀	r DIN 332	Key DIN 6885
00*	30	13	9	20	100	47	M 4	3x 3
01*	35	14	16	30	130	70	M 6	5x 5
A1*	45	14	20	32	152	80	M 8	6x 6
B1*	68	23	26	45	200	80	M 8	8x 7
C1*	85	18	32	45	235	105	M10	10x 8
D1	95	28	42	70	310	110	M12	12x 8
E1	120	29	50	75	390	190	M16	14x 9
F1	150	40	60	95	495	200	M16	18x11

Ratios i=5:1

Gearbox-size	i=5:1						d_1	
	l_2	g	$d^{⌀}_{1j6}$	l_1	m_1	o⌀	r DIN 332	Key DIN 6885
00*	–	–	–	–	–	–	–	–
01*	35	14	12	22	122	55	M 5	4x 4
A1*	45	14	16	30	150	65	M 6	5x 5
B1*	68	24	22	40	195	70	M 8	6x 6
C1*	85	18	26	45	235	95	M 8	8x 7
D1	95	23	32	58	298	105	M10	10x 8
E1	120	29	42	70	385	190	M12	12x 8
F1	150	40	55	85	485	200	M16	16x10

Ratios i=6:1

Gearbox-size	i=6:1						d_1	
	l_2	g	$d^{⌀}_{1j6}$	l_1	m_1	o⌀	r DIN 332	Key DIN 6885
00*	–	–	–	–	–	–	–	–
01*	35	14	10	22	122	50	M 4	3x 3
A1*	45	14	12	30	150	55	M 5	4x 4
B1*	68	24	16	30	185	70	M 6	5x 5
C1*	85	18	20	40	230	95	M 8	6x 6
D1	95	23	26	45	285	105	M 8	8x 7
E1	120	29	40	70	385	190	M10	12x 8
F1	–	–	–	–	–	–	–	–

[1]) tapped depth = k x 1,5 / * Available in aluminium version or corrosion proof with nickel-plated exterior / Keys to BS 4235 / DIN 6885 / shaft centrings type D to DIN 322 / Subject to modification.

Korrektur / Correction

Spiralkegelgetriebe Prospekte A 00/1 und A00/2
Spiral Bevel Gearboxes *Catalogues A 00/1e*

Auf Seite 8
Die gedruckten Angaben für den Wellen-Durchmesser d2 j6 und Länge m2 sind für die Getriebe Baugröße B1 und D1 nicht immer korrekt. Sie sind abhängig von der Übersetzung.

Page 8
The printed values for diameter on shaft d2 j6 are not always correct in sizes B1 and D1. They are dependent on ratio.

B1

i=1:1...2,5:1	m2 = 172mm
i=3:1...6:1	m2 = 180mm

D1

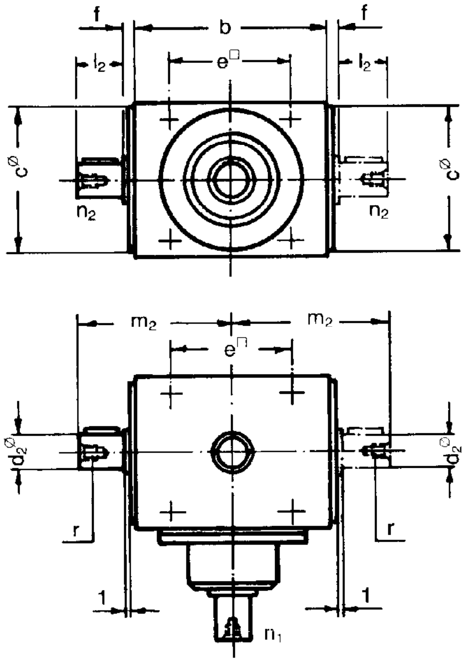
i=1:1...2,5:1	d2 j6 = 65mm
i=3:1...6:1	d2 j6 = 60mm

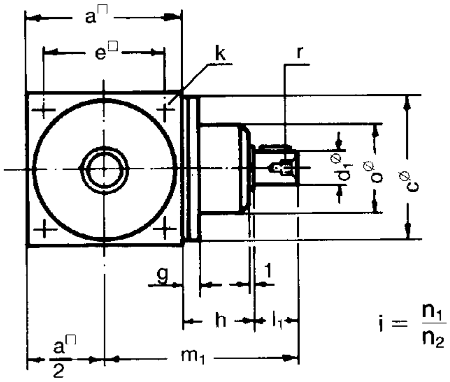
D1

i=1:1...2,5:1	m2 = 270mm
i=3:1...6:1	m2 = 265mm

13.07.2000

Speed-Increasing Ratios





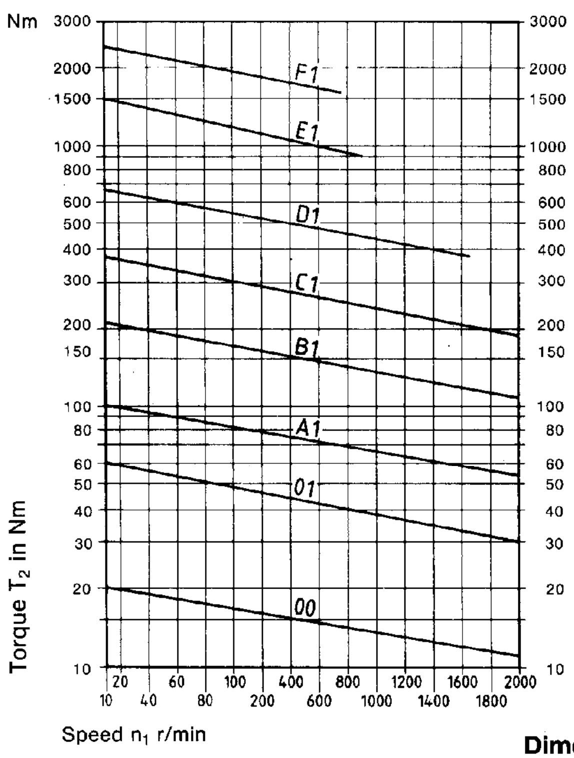
$i = \frac{n_1}{n_2}$

For special applications a gearbox series is available with speed-increasing ratio relative to n_1. It has to be taken into account here that it will be assumed by Tandler that n_1 applies to shaft d_1 and n_2 applies to shaft d_2. Ratios for this gearbox series are listed in the table below.

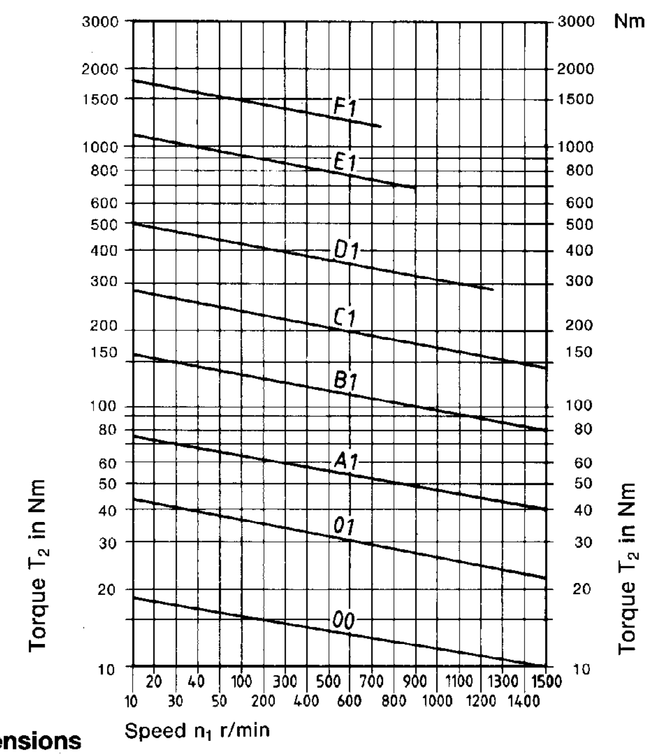
Speed-increasing Ratios	i = 1 : 1.25 i = 1 : 1.5 i = 1 : 1.75 i = 1 : 2

Please note: **There are dimensional changes to shaft d_2** in this series when ratio i = 1 : 2, compared with the standard version.

i = 1:1,25 and 1:1,5



i = 1:2

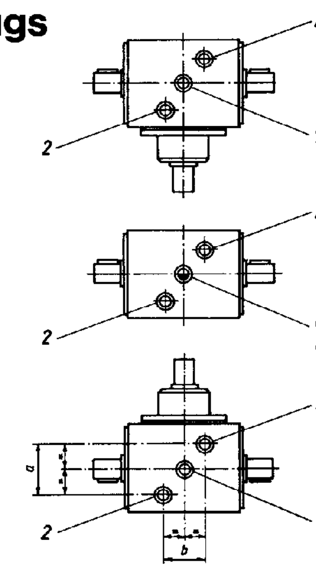


Dimensions

Gearbox-size	Ratios														i = 1 : 1,25 und 1 : 1,5					i = 1 : 2				
	General												d1					d2					d2	
	□ a	b	Ø c_{j7}	Ø d_{1j6}	□ e	m_1	l_1	f	g	h	k[1]	Ø o	r DIN 332	Key DIN 6885	Ø d_{2j6}	l_2	m_2	r DIN 332	Key DIN 6885	Ø d_{2j6}	l_2	m_2	r DIN 332	Key DIN 6885
00*	80	110	74	14	60	110	30	3,5	13	40	M 6	52	M 6	5x 5	14	30	88,5	M 6	5x 5	12	25	83,5	M 5	4x4
01*	110	145	102	22	82	135	35	3,5	14	45	M 8	70	M 8	6x 6	22	35	111	M 8	6x 6	16	30	106	M 6	5x5
A1*	140	175	130	32	105	165	45	4,5	14	50	M10	90	M10	10x 8	32	45	137	M10	10x 8	24	42	134	M 8	8x7
B1*	170	215	160	42	130	210	60	4,5	18	65	M12	110	M12	12x 8	42	60	172	M12	12x 8	28	50	162	M 8	8x7
C1*	210	260	195	55	160	275	85	5,0	18	85	M16	135	M16	16x10	55	85	220	M16	16x10	38	60	195	M12	10x8
D1	260	330	245	65	200	340	100	5,0	23	110	M16	150	M16	18x11	65	100	270	M16	18x11	50	80	250	M16	14x9
E1	330	430	310	75	260	435	120	5,0	29	150	M20	230	M20	20x12	75	120	340	M20	20x12	50	90	310	M16	14x9
F1	400	530	380	90	320	550	150	5,0	40	200	M24	270	M24	25x14	90	150	420	M24	25x14	65	130	400	M16	18x11

1) tapped depth = k x 1.5 / * Available in aluminium version or corrosion proof with nickel-plated exterior/
Keys to BS 4235 DIN 6885/shaft centrings type D to DIN 322/Subject to modification

Position of Oil Filler and Drain Plugs

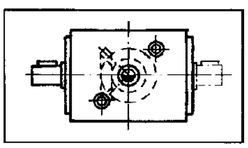


Gearbox-size	Screw plug DIN 908				Dimensions	
	Quantity	Pos. 1	Quantity	Pos. 2	a	b
00*	2	R 3/4 " *	6	M 12 x 1,5	39,6	39,6
01	2	M 30 x 1,5	6	M 12 x 1,5	58	67
A1	2	M 30 x 1,5	6	M 12 x 1,5	90	70
B1	2	M 30 x 1,5	6	M 30 x 1,5	100	68
C1	2	M 30 x 1,5	6	M 30 x 1,5	110	98
D1	2	M 30 x 1,5	6	M 30 x 1,5	146	134
E1	2	M 42 x 1,5	6	M 42 x 1,5	180	168
F1	2	M 48 x 1,5	6	M 48 x 1,5	120	230

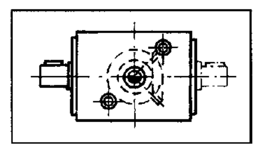
* Note! Opposite diagonal of screws. Screw plug pos. 1 not to DIN 908.

Arrangement of the oil-level gauges as per drawing S 506

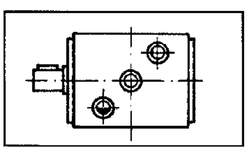
Gearbox Sizes 00; 01; and A1



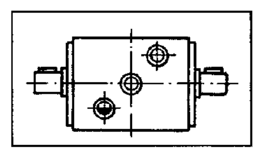
In standard gearboxes in sizes 00, 01 and A1 the oil-level gauge is located in the centre of the gear housing opposite shaft journal d_1. The correct oil level is half-way up the oil-level gauge, irrespective of the gear ratio.

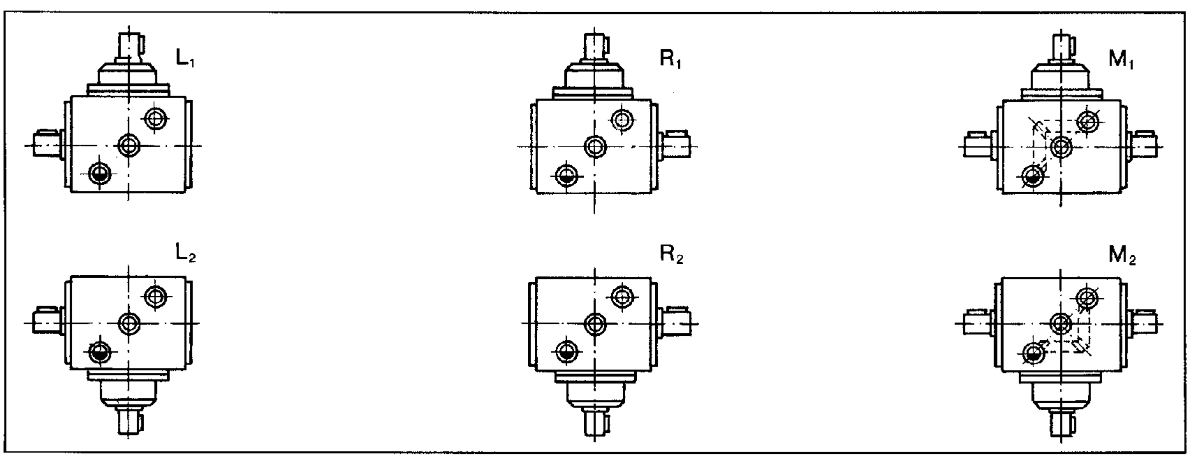


Gearbox Sizes B1; C1; D1; E1; F1



With gearbox sizes B1, C1, D1, E1 and F1 the oil-level gauges are always mounted on which ever screwconnection is the lowest according to the position of the gearbox and oil should reach halfway up the gauge. If i = 1 : 1 oil-level gauge has to be in the middle of the gearbox. If the gearbox is installed in one of the positions shown below, the oil-level gauge with O-ring seal must be repositioned. To make things simpler the position of the oil-level gauge may be specified using the following designations shown in the diagrams when an order is placed.

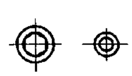




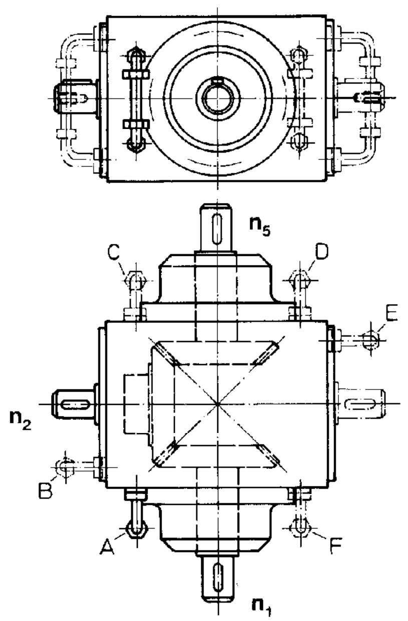
Note: Additional details for a different arrangement of the oil-level gauge must accompany the normal order description, e.g.

Spiral bevel gearboxes, standard model, size A1,
ratio $i = n_1 : n_2$, gear arrangement I

plus additional description: „Oil-level gauge as per dimension diagram S 506 R1".

 Oil-level gauge  Screw plug

Oil Gauge for One-Way and Multiple-Way Auxiliary (Branch-Off) Gearboxes – S 545

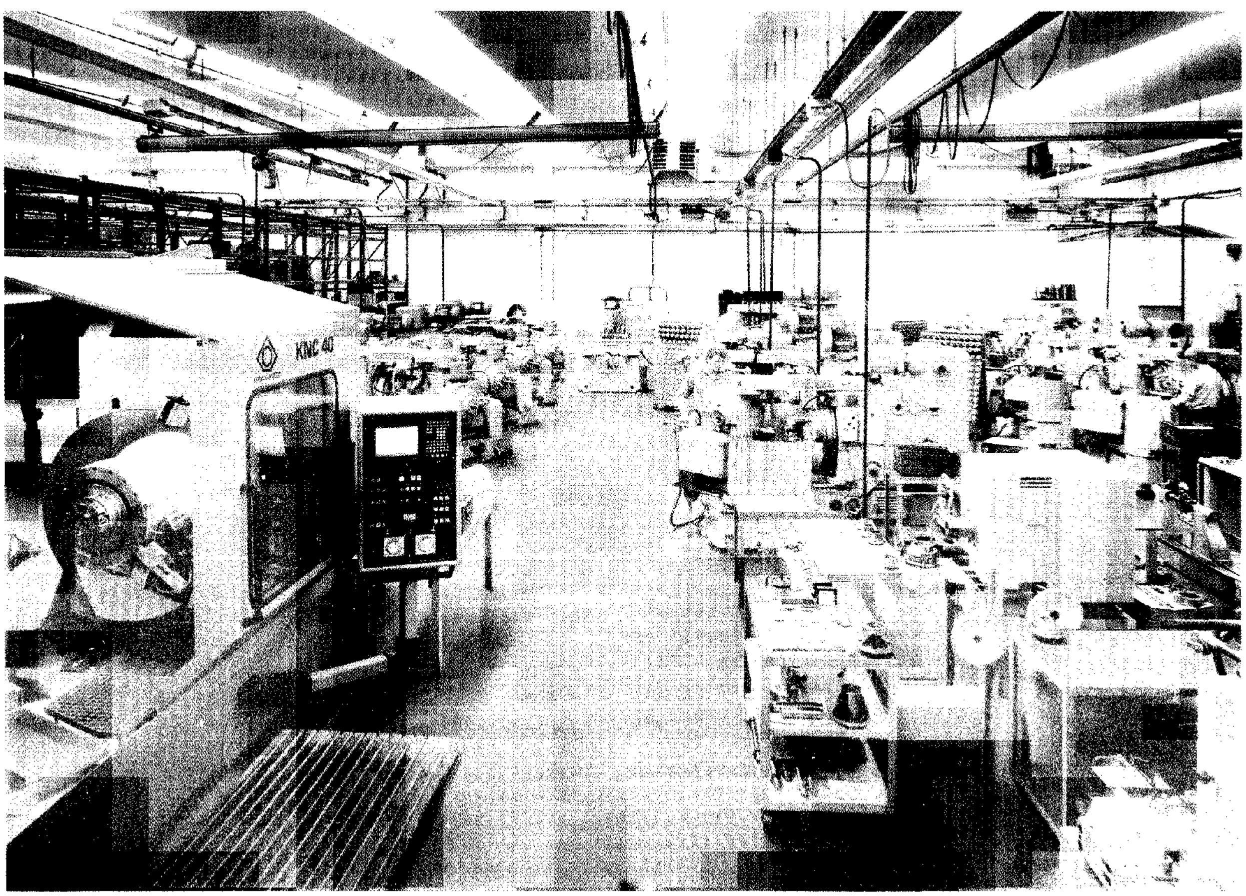


Vertical shafts n_1 and n_5
If one-way auxiliary gearboxes are installed vertically, the oil-level is monitored by the oil sight glass.

Horizontal Installation
If one-way auxiliary gearboxes are installed horizontally, the shafts are also horizontal and an oil level sight glass as shown is required. In order to position the oil gange correctly in relation to the particular gearbox design, the particular gearbox version (e.g. A, as shown in the drawing) has to be quoted.

Unless otherwise agreed, the gearboxes are supplied with oil filler elbow in the normal position, (Version B + E from type C1 onwards).

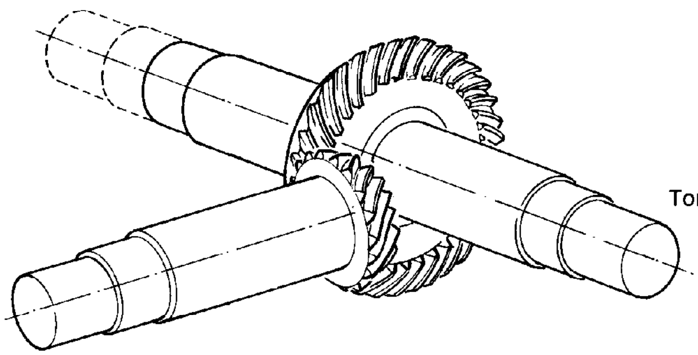
Example for Ordering:
Spiral bevel gearbox as one-way auxiliary gearbox
Type A1 Internal gear arrangement EA III
$i = n_1 : n_2 = 3 : 1$ $i = n_1 : n_5 = 1 : 1$
oil-level gauge according to version „A" S 545.



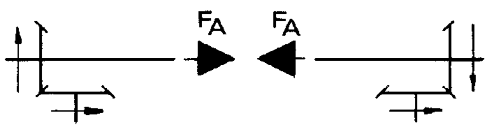
Werk II Bremen

Calculation of the permissible axial forces F_A on shaft d_2 of spiral bevel gearboxes

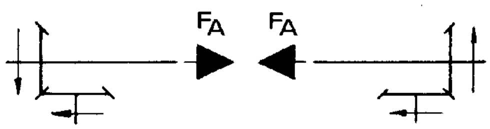
Standard Version



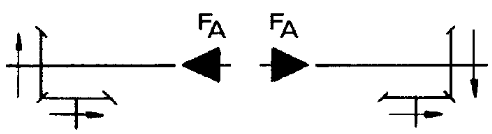
With drive on shaft d_1 ist $T_2 = i \cdot T_1$
e.g. drive on d_1 with $i = 2:1$; (fast to slow) $T_2 = 2 \cdot T_1$



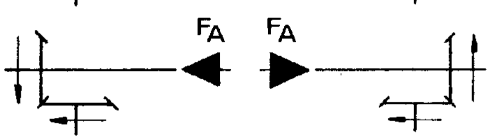
$F_A = 2{,}5 \cdot (f + A \cdot T_2) \quad = \qquad N$



$F_A = 8 \cdot (f + A \cdot T_2) \quad = \qquad N$



$F_A = 8 \cdot (f - A \cdot T_2) \quad = \qquad N$



F_A = on inquiry

Axial load factor f

n	Type 00 A = 2,4	Type 01 A = 1,6	Type A1 A = 1,25	Type B1 A = 1,0	Type C1 A = 0,85	Type D1 A = 0,65	Type E1 A = 0,55
50	400	680	1370	1940	2600	4000	4900
100	335	540	1090	1540	2100	3215	3920
200	265	430	865	1220	1670	2550	3115
300	230	375	755	1070	1460	2230	2720
500	195	315	635	900	1230	1880	2295
750	170	275	555	785	1075	1640	2000
1000	155	250	505	715	975	1490	1820
1260	140	235	470	665	905	1385	1690
1500	135	220	440	625	850	1300	1590
2000	120	200	400	565	775	1185	
2500	110	185	370	525	720		
3000	100	170	350	495			

A = factor for calculation

Heat Build-Up and Lubrication

The operational reliability of a gearbox is largely dependent on lubrication and is affected by the choice of lubricant.

The oil has to lubricate both bevel gears and roller bearings and also provide cooling.

Heat is mainly created within the gearboxes by the meshing force of gears, - sliding and rolling friction-, bearing and shaft seal friction and by churning losses, (if no oil circulation system is fitted). If no external cooling is provided the above-mentioned internal heat sources must be counterbalanced by the natural heat radiation of the gearbox outer surfaces.

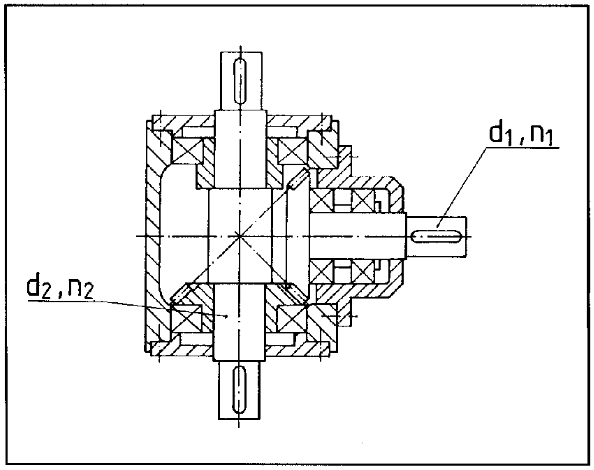
For low circumferential speeds of the bevel pinion (v = approx. 1,5 m/s) **grease lubrication** has proved successful when applied to the gears and the bearings.

Gearbox Size $i \geqq 1:1$	Circumferential speed of the bevel pinion
00	$v = 2{,}9 \cdot 10^{-3} \cdot n_2$ (m/s)
01	$v = 4{,}2 \cdot 10^{-3} \cdot n_2$ (m/s)
A1	$v = 5{,}2 \cdot 10^{-3} \cdot n_2$ (m/s)
B1	$v = 6{,}5 \cdot 10^{-3} \cdot n_2$ (m/s)
C1	$v = 7{,}8 \cdot 10^{-3} \cdot n_2$ (m/s)
D1	$v = 9{,}9 \cdot 10^{-3} \cdot n_2$ (m/s)
E1	$v = 11{,}8 \cdot 10^{-3} \cdot n_2$ (m/s)
F1	$v = 15{,}7 \cdot 10^{-3} \cdot n_2$ (m/s)

Table 1: Calculation of circumferential speed
(Note: For speed increasing ratio $i < 1:1$ speed n_2 has to replace n_1 in Table 1)

In most cases, spiral bevel gearboxes with a very efficient **oil sump lubrication** are used for moderate circumferential speeds and powers.

If, however, speeds and powers reach a level close to permitted maxima, heat build up has to be monitored closely. In order to prevent deficient lubrication at high circumferential speeds and to dissipate the heat generated, **pressure feed lubrication** instead of oil sump lubrication should be used.



Vertical shaft arrangement

Lubrication of the rolling bearings can present a problem depending on the **position in which the gearbox is installed.** In a vertical arrangement of driving or driven shaft one bearing position is at the top (Fig. 1). To avoid bearing failure due to insufficient lubrication, it may ne necessary to install a shaft seal with separate lubrication. In such cases we can advise the necessary modification.

Thermal Limit

Heat generation in spiral bevel gearboxes has to be monitored particularly at high speeds and power rates.
80-100° C is considered the maximum operating temperature (see also power diagram page 4).

If the power P_1 which is to be transmitted, exceeds the permitted thermal limit Pg_1, additional cooling, e. g. by means of cooling ribs and oil circulation system, is required.

Permitted thermal limit Pg_1 values quoted in the table apply to high gear speeds (from n = approx. 0,7 x n max.), an environmental temperature of 20° C, 100 % operating time per hour, and gearbox position with horizontal shafts. Please advise if other conditions apply.

Technical details regarding connection of oil feed pipes, cooling ribs and oil cooling systems on request.

Gearbox Type	Permitted thermal Limit Pg_1 in kW
00	4
01	7
A1	10
B1	15,5
C1	23
D1	35,5
E1	60,5
F1	90

Values quoted as permitted thermal limits Pg_1 are standard values.

Weights

Gearbox Size	Standard Vesion kg	Aluminium Version kg	Gearbox Size	kg	Gearbox Size	kg
00	5	3	–	–	–	–
01	11	7	S01	12,5	W01	15
A1	21	12	SA1	25	WA1	29,5
B1	36	23	SB1	42	WB1	50
C1	64	44	SC1	75	WC1	88
D1	124	–	SD1	145	WD1	172
E1	250	–	SE1	295	WE1	350
F1	455	–	SF1	535	WF1	630

Quoted weights are approximate values.

Lubricants

The selection of lubricants and their degree of viscosity has been made taking into account the design, circumferential speed, backlash of the teeth and operating temperature of the gearboxes. The doped mineral oils and gear lubricants shown provide the highest possible operational reliability under normal operating conditions and a long working life. At extreme temperatures and operating conditions synthetic lubricants can also be used following consultation.

Company	Type of Oil	Type of Grease
Aral	Degol BG 46	Aralub FDP 00
Shell	TellusOel 46	Shell Spezial Getriebefett H Shell Grease S 3655
Mobil-Oil	D.T.E. 25	Mobilplex 44
Esso	NUTO H 46	FIBRAX EP 370 FIBRAX 370
BP	GR-XP 46 (ISO)	BP Energrease HT-EP 00 BP Energrease FG 00-EP
Texaco	Rando Oil HD B-46	Marfak Glissando FG 30
Castrol	HYSPIN AWS 46	IMPERVIA MMO
Kluber	GEM 1-46	NATOSBIN B 1600 EP

Synthetic lubricants on request.
Random listing of oil manufacturers – independent of quality.

Quantities

The gearboxes are supplied ready for installation and filled with a specific quantity of oil depending on upon gearbox size and ratio. To ensure operational reliability the quantity of oil should not be altered. If the oil level is too low inadequate cooling and insufficient lubrication of the bevel gears will occur. If the oil level is too high, strong oil turbulence is created with the result that churning losses and oil temperature rise unnecessarily. Once the gearboxes have been run in, they should have an oil change every 2000 h – just like cars; a gearbox operated for 24 h/day should have an oil change every 1000 h.

Gearbox Size	i = 1:1	i ≠ 1:1	Grease
	litre	litre	kg
00	0,10	0,10	0,20
01	0,25	0,25	0,45
A1	0,60	0,60	1,00
B1	0,75	1,10	1,60
C1	1,50	2,25	3,00
D1	3,00	4,50	6,00
E1	8,00	11,00	15,00
F1	13,00	15,00	19,00

Listed quantities are approximate values.
The oil-level sight glass can be used for measuring the quantity.

Spiral Bevel Switch Gearboxes

With spiral bevel switch gearboxes it is possible to change the direction of rotation of power take-offs set at right angles while the direction of rotation of the drive remains constant. The drive can be provided at either d_1 or d_2.

With only one free gear on the d_2 shaft these gearboxes can also be fitted as engage/disengage gearboxes. Standard dimension switch gearboxes are manufactured with the following ratios and gear arrangements.

To obtain the correct ratio, it should be remembered that n_1 applies to pinion shaft d_1 (flange side) and n_2 applies to shaft d_2.

Spiral bevel reversing gearboxes incorporate a two-part shaft d_2 which permits the same or opposite directions of rotation, depending on their lever setting. Further, it is important to distinguish between the version with or without the pinion shaft journals d_1.

S Version

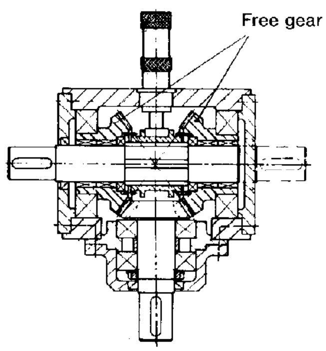


Illustration
of neutral position

AS Version

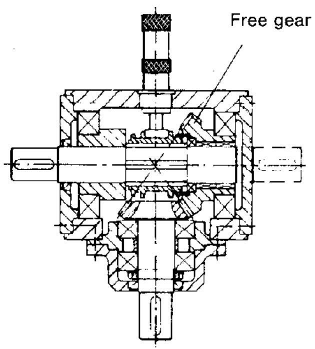


Illustration
of neutral position

Reversing Gearbox

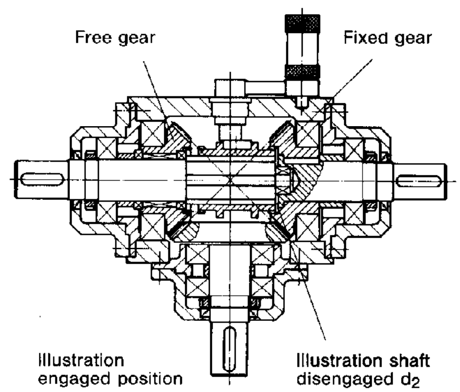
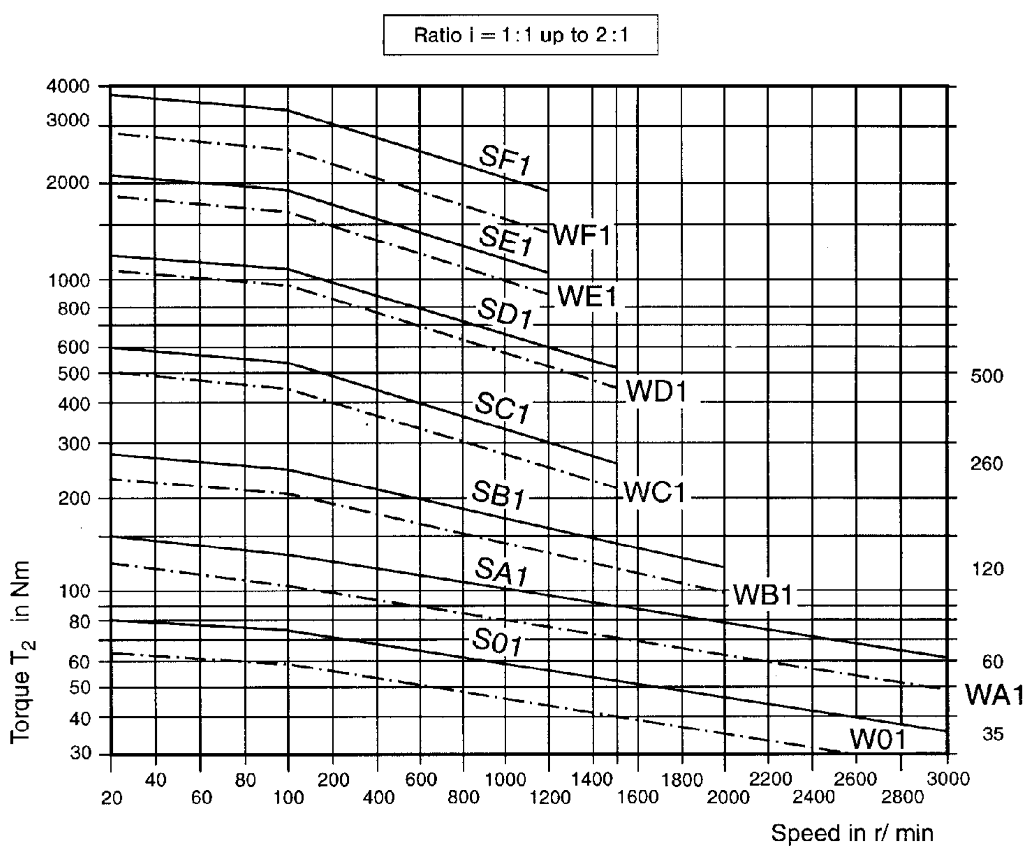


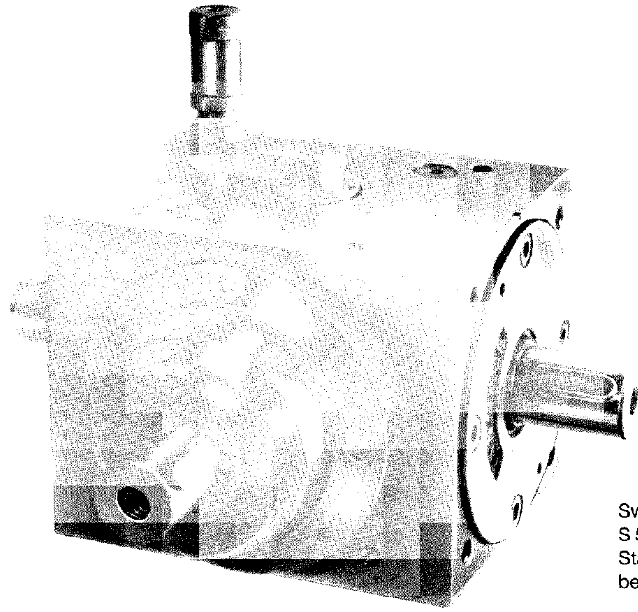
Fig. 1: Spiral bevel reserving gearbox with pinion shaft journal

Performance Characteristics

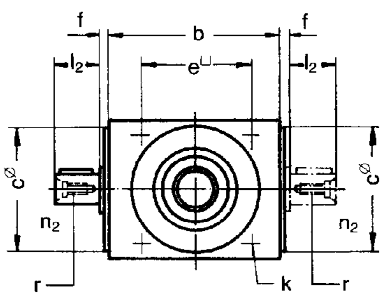
Switch Gearboxes

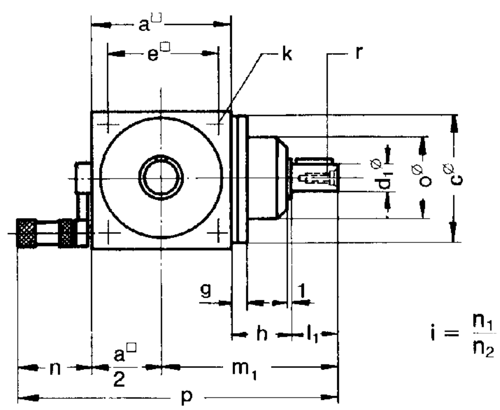


Spiral Bevel Switch Gearboxes

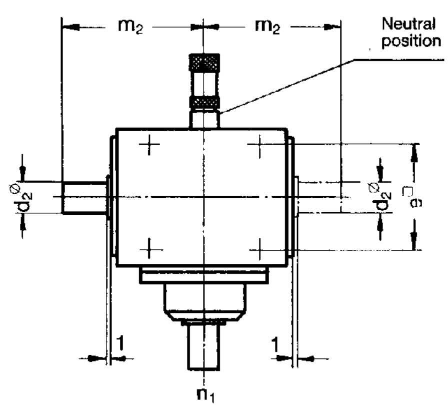


Switch lever shown in position S 507-01 (see page 21/22). Standard position as drawing below.





$i = \frac{n_1}{n_2}$

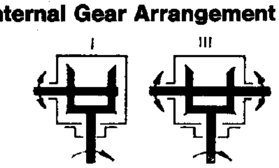


Switch Gearboxes

Gears with palloid spiral teeth

Ratios	i = 1 : 1 i = 1,25 : 1 i = 1,5 : 1 i = 2 : 1

Internal Gear Arrangement



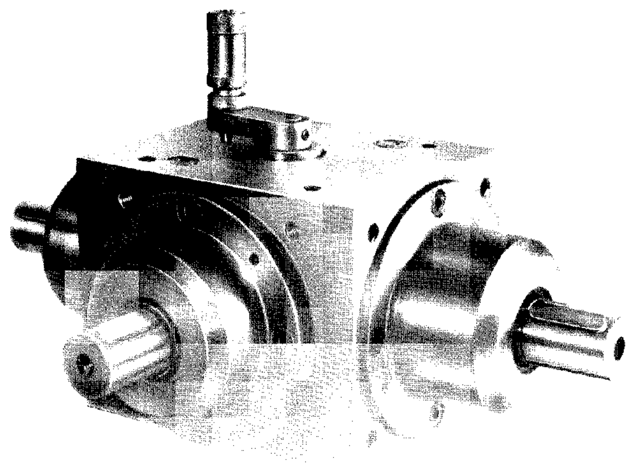
Dimensions

Gearbox-size	a□	b	$c_{j7}^{ø}$	$d_{1j6}^{ø}$ $d_{2j6}^{ø}$	e□	f	g	h	k[1]	l_1 l_2	m_1	m_2	n	o[ø]	p	r DIN 332	Key DIN 6885 BS 4235	Lever- ∡ [2)]
	Ratios i = 1 : 1, 1,25 : 1, 1,5 : 1, 2 : 1																	
S **01***	110	145	102	22	82	3,5	14	45	M 8	35	135	111	65	70	255	M 8	6x 6	70° to 80°
S **A1***	140	175	130	32	105	4,5	14	50	M10	45	165	137	65	90	300	M10	10x 8	
S **B1***	170	215	160	42	130	4,5	18	65	M12	60	210	172	80	110	375	M12	12x 8	
S **C1***	210	260	195	55	160	5,0	18	85	M16	85	275	220	80	135	460	M16	16x10	
S **D1***	260	330	245	65	200	5,0	23	110	M16	100	340	270	80	150	550	M16	18x11	

[1]) tapped depth = k x 1,5 / [2]) from 0-position / * Available in aluminium version or corrosion proof with nickel-plated exterior / Keys to BS 4235 / DIN 6885 / Centrings type D to DIN 332 / Subject to modification.

Spiral Bevel Reversing Gearboxes

W Version



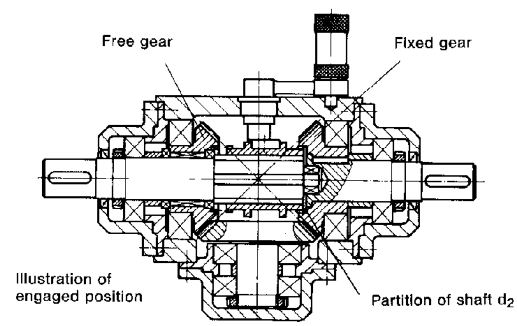


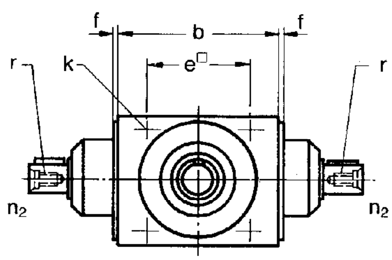
Fig. 2: Spiral bevel reversing gearbox without pinion shaft d_1.

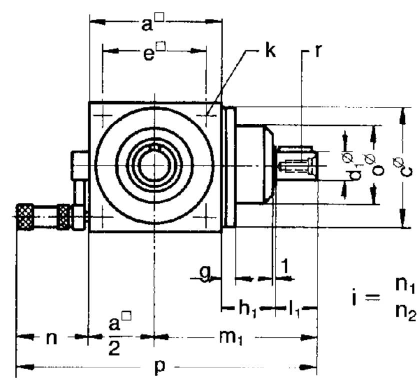
In comparison with switch gearboxes reversing gearbox types have to accommodate higher flank loads which must be allowed for by design data by means of factor w (w = 1,2). Accordingly the corrected output torque ist as follows:

$$T_k = T_2 \times 1{,}2 \times c$$

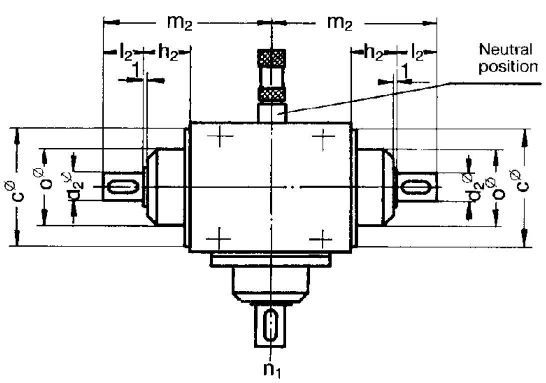
c = operating factor page 5

Using the performance characteristics for switch gearboxes on page 18 design data for reversing gearboxes can therefore also be established.





$$i = \frac{n_1}{n_2}$$



Reversing Gearboxes.

Gears with palloid spiral teeth.

Dimensions

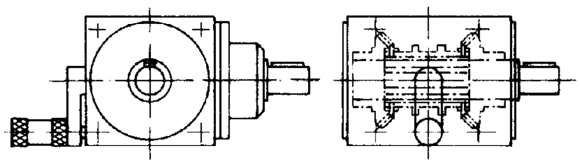
Ratios i = 1:1, 1,25:1, 1,5:1, 2:1																			
Gearbox-size	$a^{\square}$	b	$c^{\varnothing}_{j7}$	$d^{\varnothing}_{1j6}$ $d^{\varnothing}_{2j6}$	$e^{\square}$	f	g	h_1	h_2	k^1	l_1 l_2	m_1	m_2	n	$o^{\varnothing}$	p	r DIN 332	Key DIN 6885 BS 4235	Lever- ∢ 2)
W **01***	110	145	102	22	82	8,0	14	45	47,5	M 8	35	135	155	65	70	255	M 8	6x 6	
W **A1***	140	175	130	32	105	8,0	14	50	60,5	M10	45	165	193	65	90	300	M10	10x 8	70°
W **B1***	170	215	160	42	130	6,5	18	65	69,5	M12	60	210	237	80	110	375	M12	12x 8	to
W **C1***	210	260	195	50	160	6,0	18	85	73,0	M16	85	275	288	80	135	460	M16	14x 9	80°
W **D1**	260	330	245	60	200	7,0	23	110	94,0	M16	95	335	354	80	150	545	M16	18x11	

1) tapped depth = k x 1.5 / 2) from 0-position / * Available in aluminium version or corrosion proof with nickel-plated exterior / Keys to BS 4235 / DIN 6885 / Centrings type D to DIN 332 / Subject to modification.

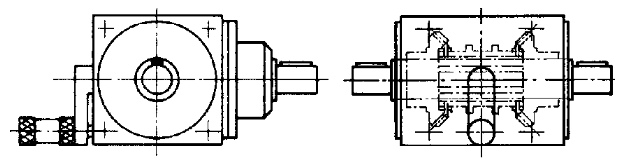
Serial Bevel Switch Gearboxes

Arrangement of gear shift levers as per dimension drawing S 507

Generally: In the standard version the gear-shift lever is mounted opposite the pinion shaft d1 in the position shown in the drawing.



Gear arrangement I



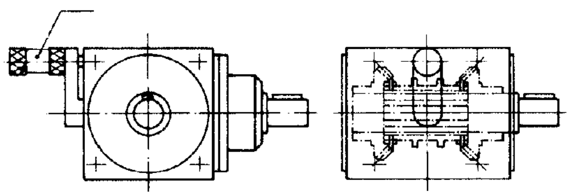
Gear arrangement III

Note: For special installation conditions the gear-shift lever can also be installed as shown in the following sketches. When placing your order you must then specify gear-shift lever as shown in dimension drawing S 507 . . . . . . adding the required version (e.g. „U2").

Gear Arrangement I

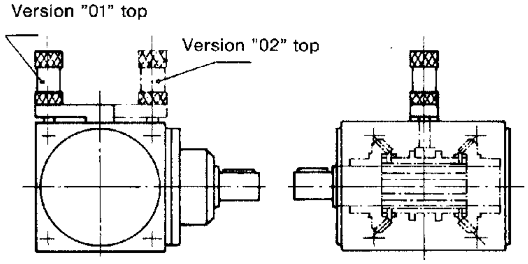
S 507 N1

Normal version "N1"

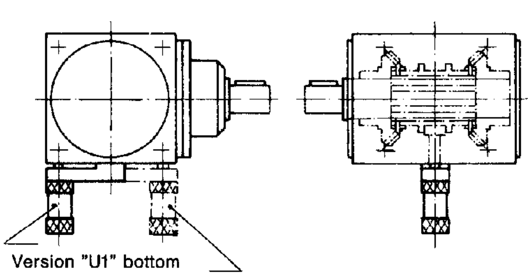


S 507 01 or 02

Version "01" top



S 507 U1 or U2



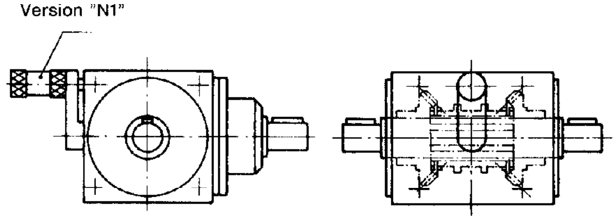
Version "U1" bottom

Version "U2" bottom

Gear Arrangement III

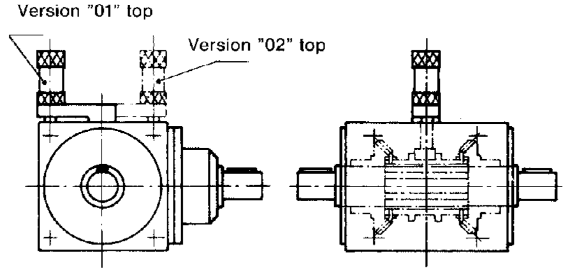
S 507 N1

Version "N1"

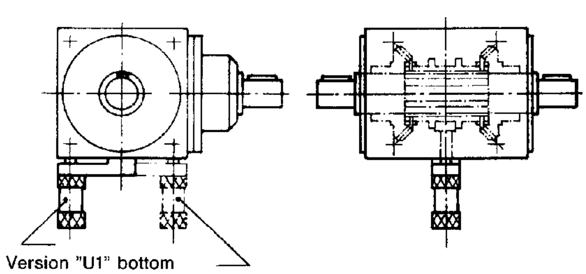


S 507 01 or 02

Version "01" top



S 507 U1 or U2



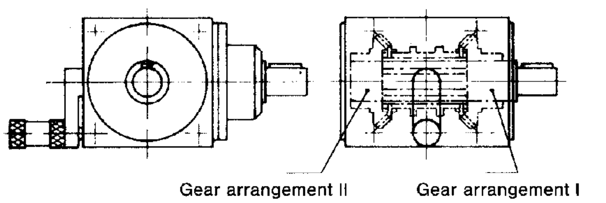
Version "U1" bottom

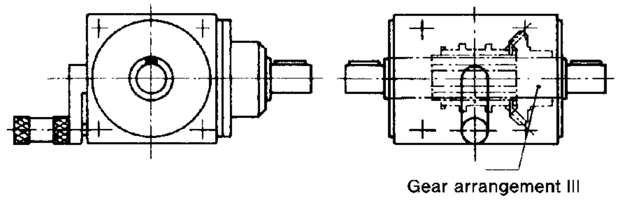
Version "U2" bottom

Spiral Bevel Switch-off Gearboxes

Arrangement of the gear-shift lever as per dimension drawing S 507

Generally: In the standard version the gear-shift lever is mounted opposite the pinion shaft d1 in the position shown in the drawing.

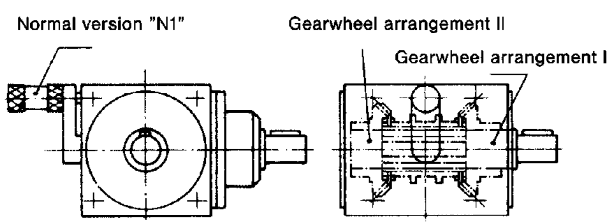




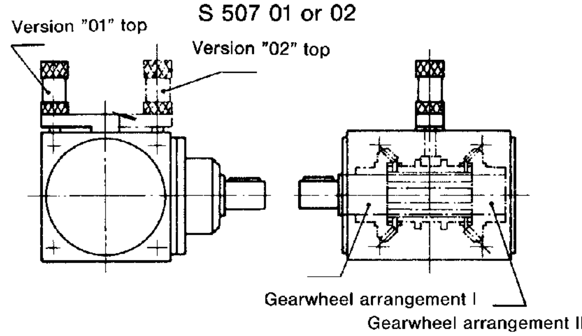
Note: For special installation conditions the gear-shift lever can also be installed as shown in the following sketches. When placing your order you must then specify gear-shift lever as shown in dimension drawing S 507 . . . . . . adding the required version (e.g. „U2").

Gear Arrangement I or II

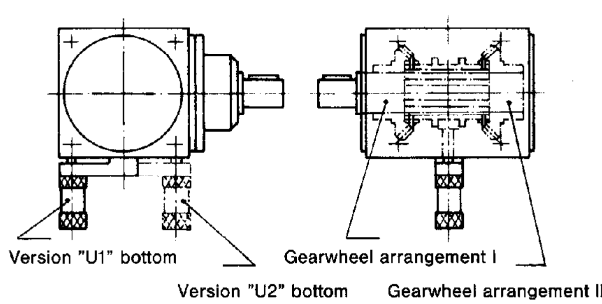
S 507 N1



S 507 01 or 02

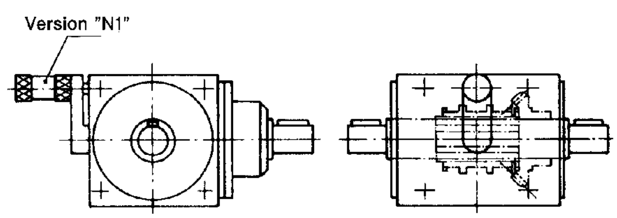


S 507 U1 or U2

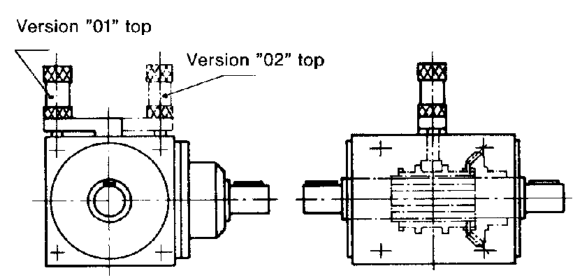


Gear Arrangement III

S 507 N1



S 507 01 or 02



S 507 U1 or U2